

Telescopes as Time Machines

This activity is designed for use at a telescope of almost any size to illustrate the distances of objects you are viewing.

Developed as part of the Night Sky Network's *Our Galaxy, Our Universe* ToolKit, you can also use this in your own backyard or on a camping trip with little modification. Read over the instructions and watch the video to get a better idea of what you will be doing at the telescope.

Be sure to print out the final two pages of this document and make enough copies for each person at the telescope. Enjoy!

If you would like more information about the night sky, we encourage you to visit your local astronomy club.

Find out more here:

<http://nightsky.jpl.nasa.gov/club-map.cfm>





Telescopes as Time Machines

What is this activity about?

Big Question: How long has the light we see now from different objects in the universe been traveling to reach us tonight?

Big Activity: A journey through time to view in the telescopes at least one object from each of three different distance categories: within our Solar System, within the Milky Way, within the rest of the universe. The guide is a "Passport through Time." Visitors can view multiple objects within each category and keep a record of what objects they saw.

Participants: From the club: A minimum of one person with a telescope up to all telescope providers at a public star party.

Visitors: Appropriate for families, the general public, and school groups in grades 4 and up.

Duration: The "Passport Through Time" can be used for the duration of the star party, typically one or two hours.

Topics Covered:

- How long did it take the light we are seeing tonight from distant objects to reach us?
- How is looking farther away looking back in time?

Where can I use this activity?

Telescopes as Time Machines is designed for use at a **star party** or public astronomy night.

Pre Star Party:

Provide an introduction to your visitors. Refer to the **Detailed Activity Description** for a suggested script.

You might also consider using the activities in the ToolKit, “A Universe of Galaxies” or the “Our Place in our Galaxy”, as an introduction.

At the Telescope:

The participating club members at the telescopes should have a copy of the passport so they know what their visitors are referring to. The exact distance of the object they are viewing is not important, just whether it is in our solar system, in the Milky Way, or a galaxy outside the Milky Way. Be prepared to relate that distance to historical events in human history or the history of life on earth. This helps to give your visitors a concrete reference point that leads to a clearer understanding.

The telescope operators may want to refer to the galaxy CDs from “A Universe of Galaxies” and the constellation/asterism CDs from “Our Place in Our Galaxy” for distances to the objects being observed.

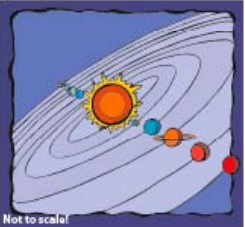


Completion Stickers:

Instead of (or in addition to) completion stickers, you may want to provide a small prize or other giveaway. Use of the stickers is optional.



Helpful Hints

Distances in astronomy are so vast, that it is often difficult to put them perspective. In this activity, visitors are given a passport with three categories: objects in the Solar System, objects outside the Solar System but still within the Milky Way Galaxy, and galaxies outside of our own. Their challenge is to view at least one object from each category during the course of the star party. By giving an overview of the categories when the passports are handed out, you are empowering your visitors to ask questions as they travel through the telescopes.

Solar System	Milky Way Galaxy	A Universe of Galaxies
 <p>Not to scale!</p>	 <p>Photo Credit: NASA/JPL/NSE</p>	 <p>Photo Credit: NASA, ESA, S. Beckwith (STScI)</p>
<p>Most light we see from objects in the solar system has traveled for minutes or hours.</p>	<p>Light from objects in our Galaxy has traveled a few years to thousands of years.</p>	<p>Most light from other galaxies has traveled millions to billions of years.</p>
<p>minutes → hours</p>	<p>few years → thousands of years</p>	<p>few million → billions of years</p>
<p>Moonlight takes less than 2 seconds to reach you. Sunlight takes about 8 minutes. Light from Saturn has traveled for over an hour. Light from Pluto's surface has traveled over 5 hours.</p>	<p>All the individual stars you see when you look up at the sky, or through the telescope are in our Milky Way Galaxy.</p>	<p>As we look past the stars in our Milky Way Galaxy, we can peek out and see other galaxies in the rest of the Universe.</p>
<p>Where were you when the light from the planet you saw tonight started on its way to your eye?</p>	<p>Some of the light you see began its journey before your grandfather was born, before Columbus came to America, or even before the Great Pyramid was built.</p>	<p>Some of the light started its journey before modern humans were on Earth, some before the time of the dinosaurs, and some even before the Earth existed!</p>
<p>What I saw in our Solar System:</p>	<p>What I saw in our Milky Way Galaxy:</p>	<p>What I saw outside of our Galaxy:</p>
<p>Sun: _____</p>	<p>Star Nursery: _____</p>	<p>Galaxy: _____</p>
<p>Moon: _____</p>	<p>Young star cluster: _____</p>	<p>Galaxy: _____</p>
<p>Planet: _____</p>	<p>Dying or exploded star: _____</p>	<p>Galaxy: _____</p>
<p>Satellite: _____</p>	<p>Old star cluster: _____</p>	<p>Galaxy: _____</p>
<p>_____</p>	<p>Double star: _____</p>	<p>Galaxy: _____</p>
<p>_____</p>	<p>_____</p>	<p>_____</p>

Background Information


A frequent question by a visitor at the eyepiece is, “How far can you see with your telescope?” This activity helps to answer this question in a fun way by keeping the categories of distant objects simple and linked to the amount of time it takes that light to reach us.

Light we are seeing now from objects in the Solar System has been traveling for less than a day. For all objects except the Sun, we are seeing reflected sunlight coming from these objects. Check your favorite magazine or website to find out which planets, or the Moon, will be observable the night of your event.

Light we see now from stars and nebulae within our Milky Way Galaxy has been traveling for a few years to tens of thousands of years. You may choose stars or favorite Messier objects that are not galaxies.

Light we see tonight from most of the other galaxies has been traveling for more than a million years.

Detailed Activity Description

Leader's Role	Participant's Role
<p>Preparation:</p> <p>To do:</p> <ol style="list-style-type: none"> 1. Each participating amateur astronomer may pick any object(s) he or she wishes to show and that his or her telescope is capable of viewing. 2. Give each participating club member a copy of the Passport. Explain that your visitors will have these and be on a "Tour" to look at objects in these categories. The amateur astronomers need to be prepared to tell the visitor what kind of object they are viewing and whether it is within the Solar System, the Milky Way, or if it another galaxy outside our own Galaxy. 	
<p>Introduction with your visitors:</p> <p><u>To Ask:</u> Have any of you ever wished you could travel back in time?</p> <p><u>To Say:</u> Well, when you look through our club members' telescopes tonight, you will be doing just that. Think of these telescopes as time machines. The light we are seeing tonight from planets, stars, and other galaxies traveled for a few minutes to a few years to a few million years to reach us,</p> <p>As you see objects farther and farther away from Earth, the longer the light takes to reach us.</p>	<p>Responses</p>

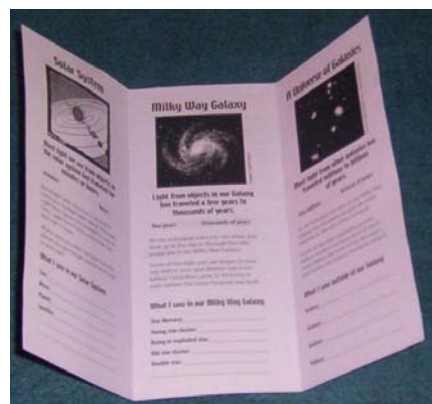
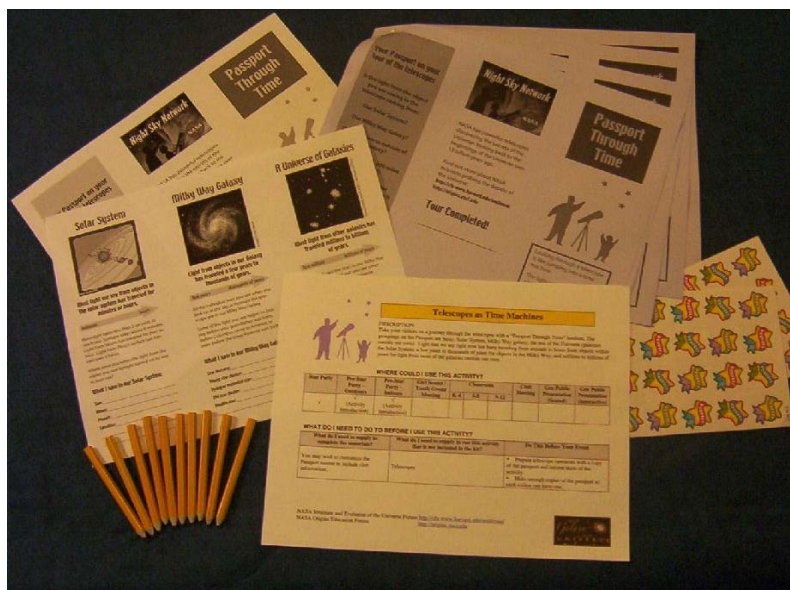
<i>Leader's Role</i>	<i>Participant's Role</i>
<p><u>To do:</u> Turn on your red flashlight so your visitor can see the light.</p> <p><u>To Ask:</u> After I turn on this flashlight, how long before you see the light from it?</p> <p><u>To Say:</u> Usually we think of light as traveling so fast, you don't notice its travel time. But distances are so vast in space that it <i>does</i> take time for that light to reach us. Light only travels 186,000 miles per <i>second</i> or a little more than 11 million miles in a <i>minute</i>.</p> <p><u>To Ask:</u> How far away is the sun from Earth?</p> <p>So how long does it take light leaving the sun right now to reach Earth?</p>	<p>Instantly.</p> <p>93 million miles</p> <p>about 8-1/2 minutes!</p>
<p>(Solar System)</p> <p><u>To Say:</u> In the case of those objects in our solar system, light reaches our eyes in seconds, minutes, or hours.</p> <p><u>To do:</u> (Pick an object that is visible now, say the moon.)</p> <p><u>To Say:</u> That light we see right now just left the moon a second and half ago, but the light from Saturn left over an hour ago. What were you doing an hour ago? Finishing up supper? On your way here?</p> <p>So is Saturn farther away than the Moon?</p> <p>For everything within our Solar System, it takes less than a day for the light to reach us.</p>	<p>Individuals should shout out answers</p> <p>Yes.</p>
<p>(Milky Way Galaxy)</p> <p><u>To Say:</u> For objects outside our Solar System, but within our Milky Way Galaxy it is much longer. Not just days, but years, from a few years to tens of thousands of years.</p> <p><u>To Do:</u> Pick a nearby star, for example, Sirius. (or Vega, at 25 light years)</p> <p><u>To Say:</u> If there are any nine year olds in the crowd, that starlight has been traveling as long as you have been alive and is just getting here tonight. So you are seeing that star as it was how many years ago?</p>	<p>Nine!</p>

<i>Leader's Role</i>	<i>Participant's Role</i>
<p>(Rest of the Universe)</p> <p><u>To Ask:</u> When you view most of the galaxies outside our Milky Way Galaxy, you are looking at light that left <i>millions</i> of years ago. Before modern humans were on Earth – before the Stone Age - over 2 million years ago. Even back to the time of the dinosaurs – when was that?</p> <p><u>To Say:</u> NASA scientists study this light from long ago to learn about how stars and galaxies form. By studying more and more distant galaxies, we can learn how galaxies looked millions and even billions of years ago.</p>	<p>Before 65 million years ago.</p>
<p><u>To Do:</u> Hold up the Passport and point to the three different categories</p> <p><u>To Say:</u> This Passport can be used to guide your journey back in time. For each object you see in the telescope, determine if it is in our Solar System, in our Milky Way Galaxy or somewhere outside of our galaxy.</p> <p>Ask the various people sharing their telescopes with you tonight how long the light has been traveling that is reaching your eye. If the light you are seeing now left that object <i>today</i>, would it be in the Solar System, out in the rest of the Milky Way Galaxy, or in a Galaxy beyond our own Milky Way?</p> <p>How long ago were the dinosaurs on Earth?</p> <p>If you are seeing light that has been traveling since the time of the dinosaurs, which of these categories would that object be in?</p> <p>(Optional): You will also be given a pencil to record which objects you viewed, (Optional): After you have seen at least one object in each category, you will have earned a completion sticker. (Explain the procedure you have chosen to distribute the completion stickers – or other prize). (<i>Hand out Passports, pencils</i>) So enjoy your trip into the past and take a journey back in time each time you look through an eyepiece.</p>	<p>Solar System</p> <p>65 million years ago. Galaxies beyond the Milky Way.</p>

Materials

What Materials from the ToolKit do I need?

- Master of the "Passport through Time" handout (both sides)
- Copies of the Passport – this is designed as a tri-fold (see photos of folded passport)
- Pencils (optional)
- Completion stickers (optional)




What must I supply?

- Telescopes

What do I need to prepare?

- Prepare telescope operators with a copy of the passport and inform them of the activity.
- Make enough copies of the passport so each visitor or family can have one.
- You may wish to customize the Passport master to include your club information. On the back of the Passport is a space for this:



NASA has powerful telescopes discovering the secrets of the Universe—looking back to the beginnings of the Universe over 13 billion years ago.

Find out more about NASA missions probing the depths of the Universe:
<http://da-www.harvard.edu/seuforum>
<http://origins.stsci.edu>

Tour Completed!

Your Passport on your tour of the telescopes

Is the light from the object you are seeing in the telescope coming from:

Our Solar System?

Our Milky Way Galaxy?

Or the Universe outside of our Galaxy?

Light travels 186,000 miles each second !

Consider how long that light was traveling before it reached your eye.

Keep a log of each object you see on your tour!



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Tour Completed!

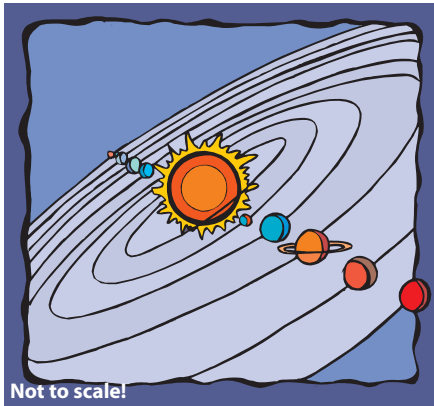
Passport Through Time



Looking through a telescope is like jumping into a time machine.

The light we see from most objects out in space has been traveling from a few minutes to millions or even billions of years.

Solar System



Most light we see from objects in the solar system has traveled for minutes or hours.



Moonlight takes less than 2 seconds to reach you. Sunlight takes about 8 minutes. Light from Saturn has traveled for over an hour. Light from Pluto's surface has traveled over 5 hours.

Where were you when the light from the planet you saw tonight started on its way to your eye?

What I saw in our Solar System:

Sun: _____
Moon: _____
Planet: _____
Satellite: _____

Milky Way Galaxy



Light from objects in our Galaxy has traveled a few years to thousands of years.



All the individual stars you see when you look up at the sky, or through the telescope are in our Milky Way Galaxy.

Some of the light you see began its journey before your grandfather was born, before Columbus came to America, or even before the Great Pyramid was built.

What I saw in our Milky Way Galaxy:

Star Nursery: _____
Young star cluster: _____
Dying or exploded star: _____
Old star cluster: _____
Double star: _____

A Universe of Galaxies



Most light from other galaxies has traveled millions to billions of years.



As we look past the stars in our Milky Way Galaxy, we can peek out and see other galaxies in the rest of the Universe.

Some of the light started its journey before modern humans were on Earth, some before the time of the dinosaurs, and some even before the Earth existed!

What I saw outside of our Galaxy:

Galaxy: _____

Galaxy: _____

Galaxy: _____

Galaxy: _____